

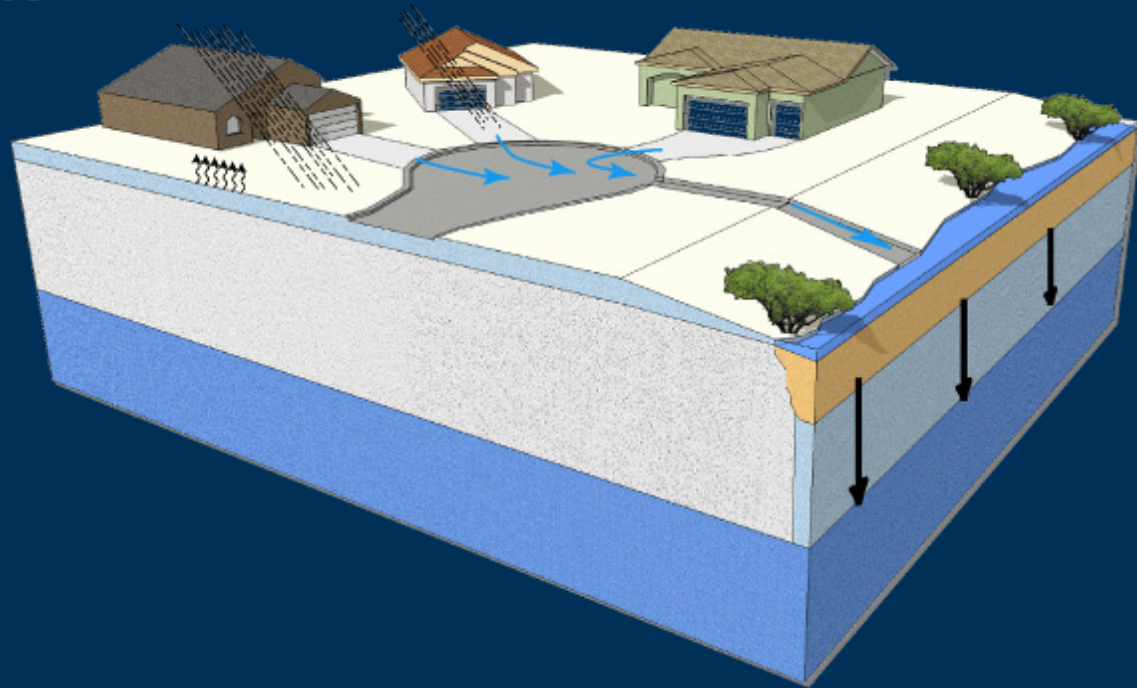


Suburban Stormwater Runoff at La Terraza, Sierra Vista, Arizona

Jeff Kennedy

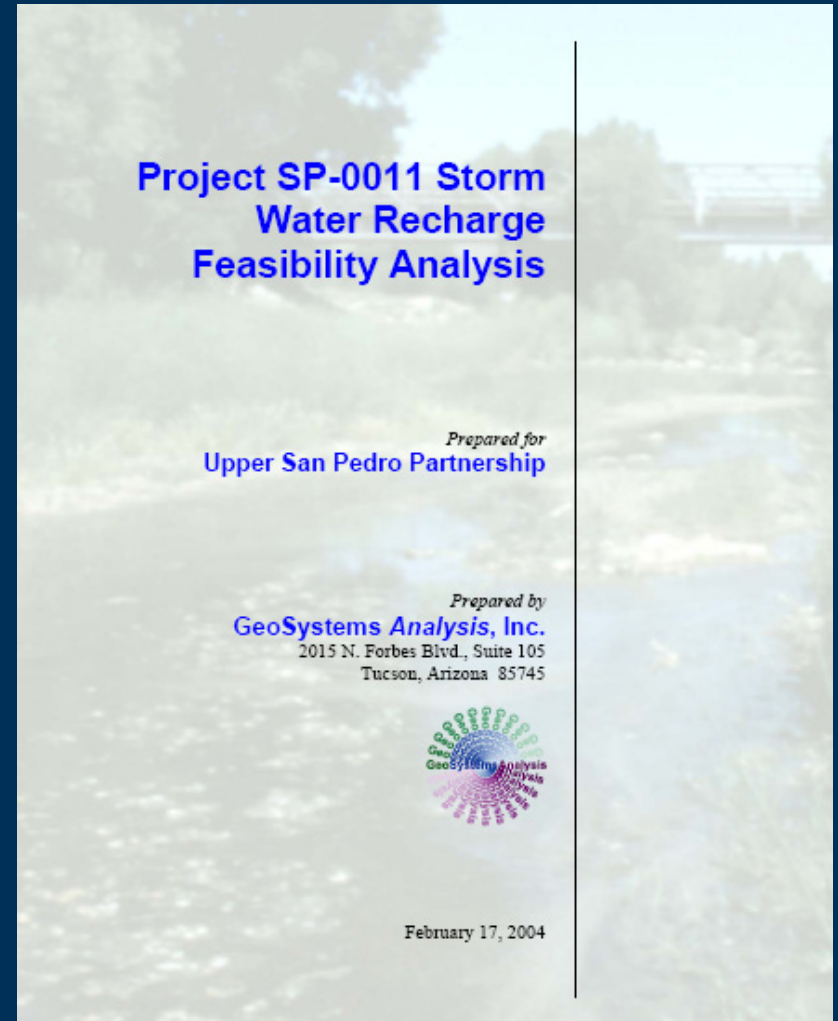
Introduction

- ‘Urban enhanced recharge’
- Urbanization = more runoff
= more infiltration
= more recharge
- Requires an understanding of each process



Background

- 2004 GSA / ARS report
- Used the same runoff model, in a different manner
- Estimated a 40% increase in runoff volume and 200-300 acre-feet/year recharge in ephemeral channels





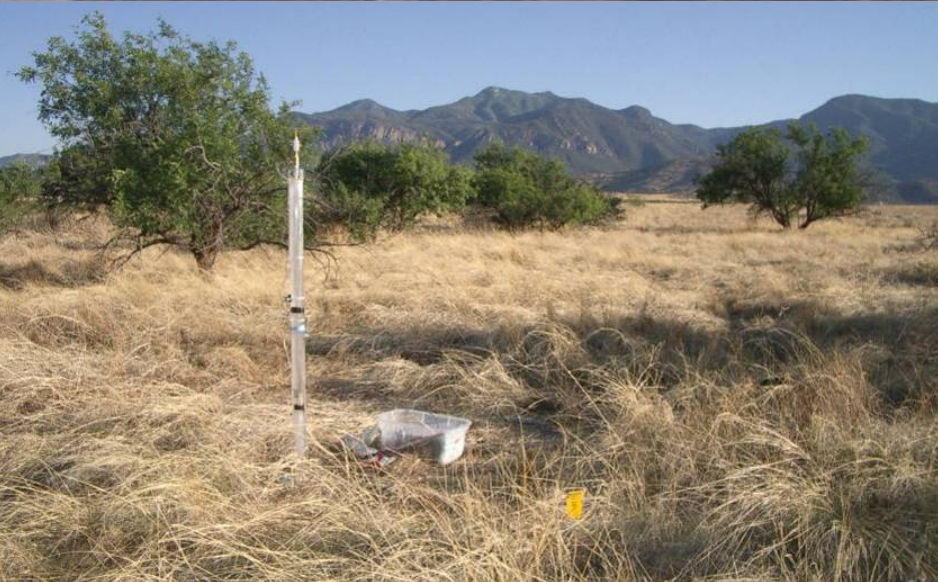
Fry Boulevard

Fort Huachuca

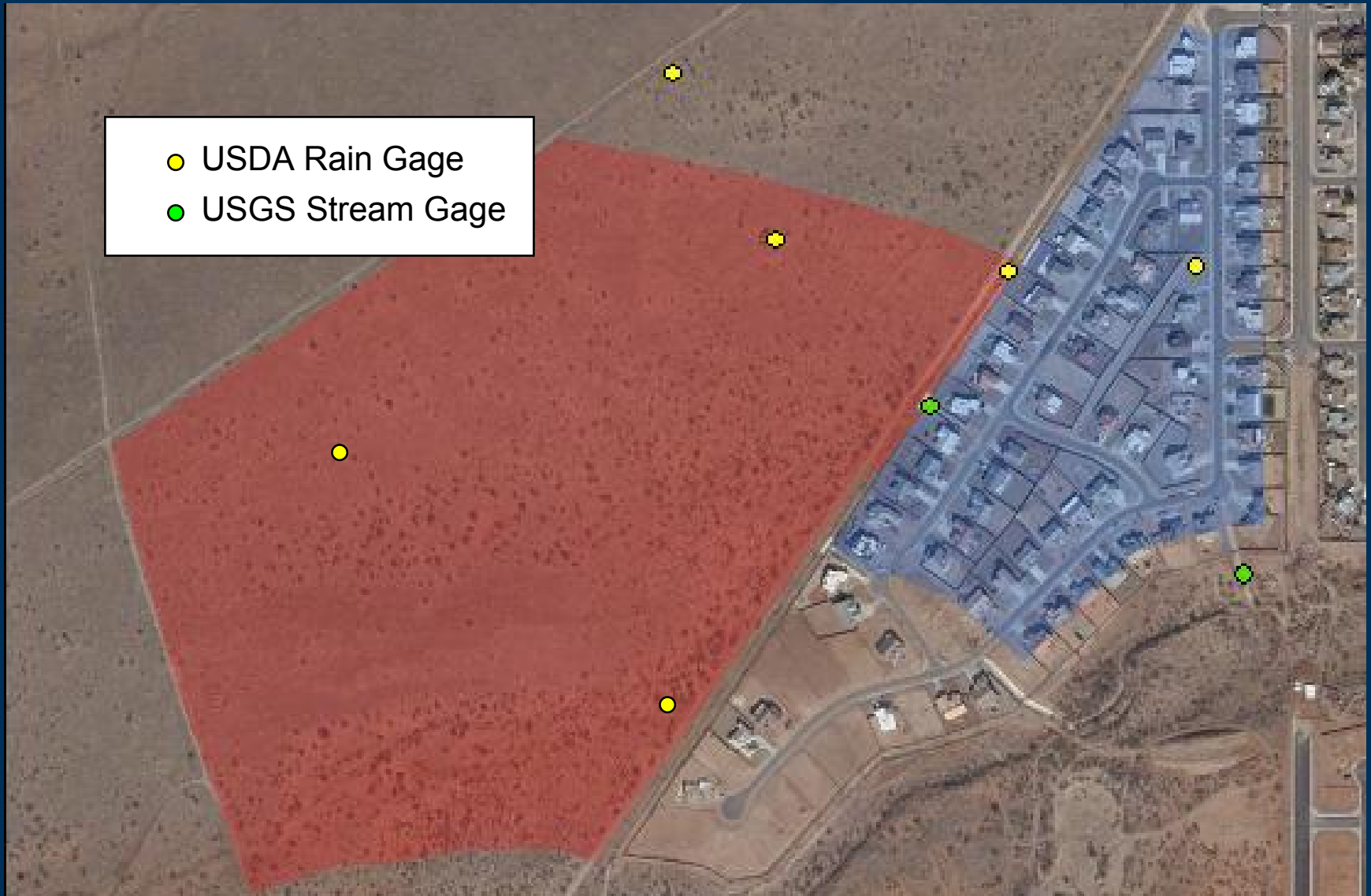
Sierra Vista

HWY 92

Image © 2007 DigitalGlobe



Study Area – established 2005

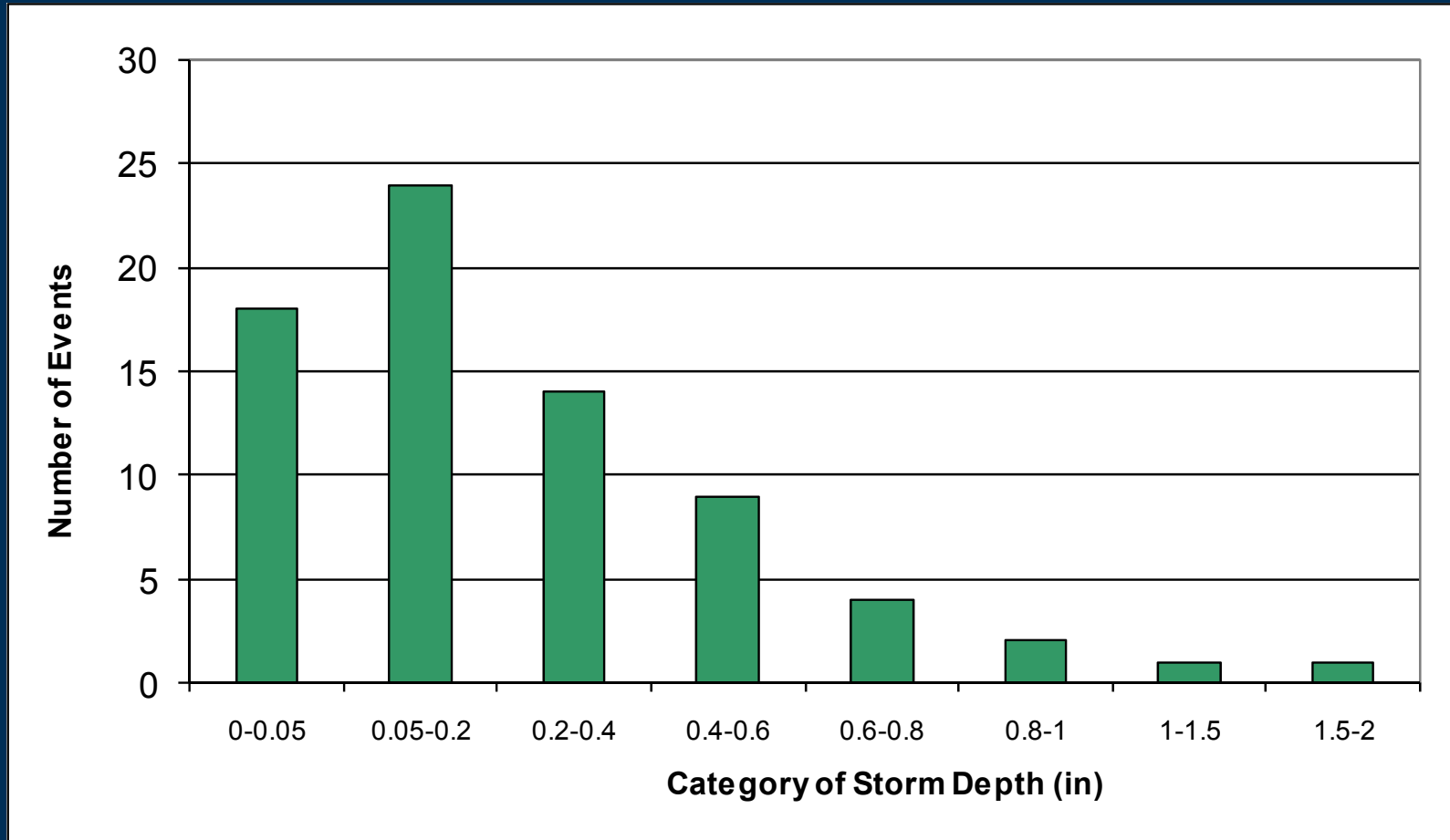


Rainfall and Runoff Measurement

- 2 v-notch weirs
- 6 weighing recording rain gages with soil moisture probes
- Data available online in near “real-time”
 - Runoff data
USGS NWISweb - waterdata.usgs.gov
 - Rainfall data
USDA-ARS - www.tucson.ars.ag.gov/dap

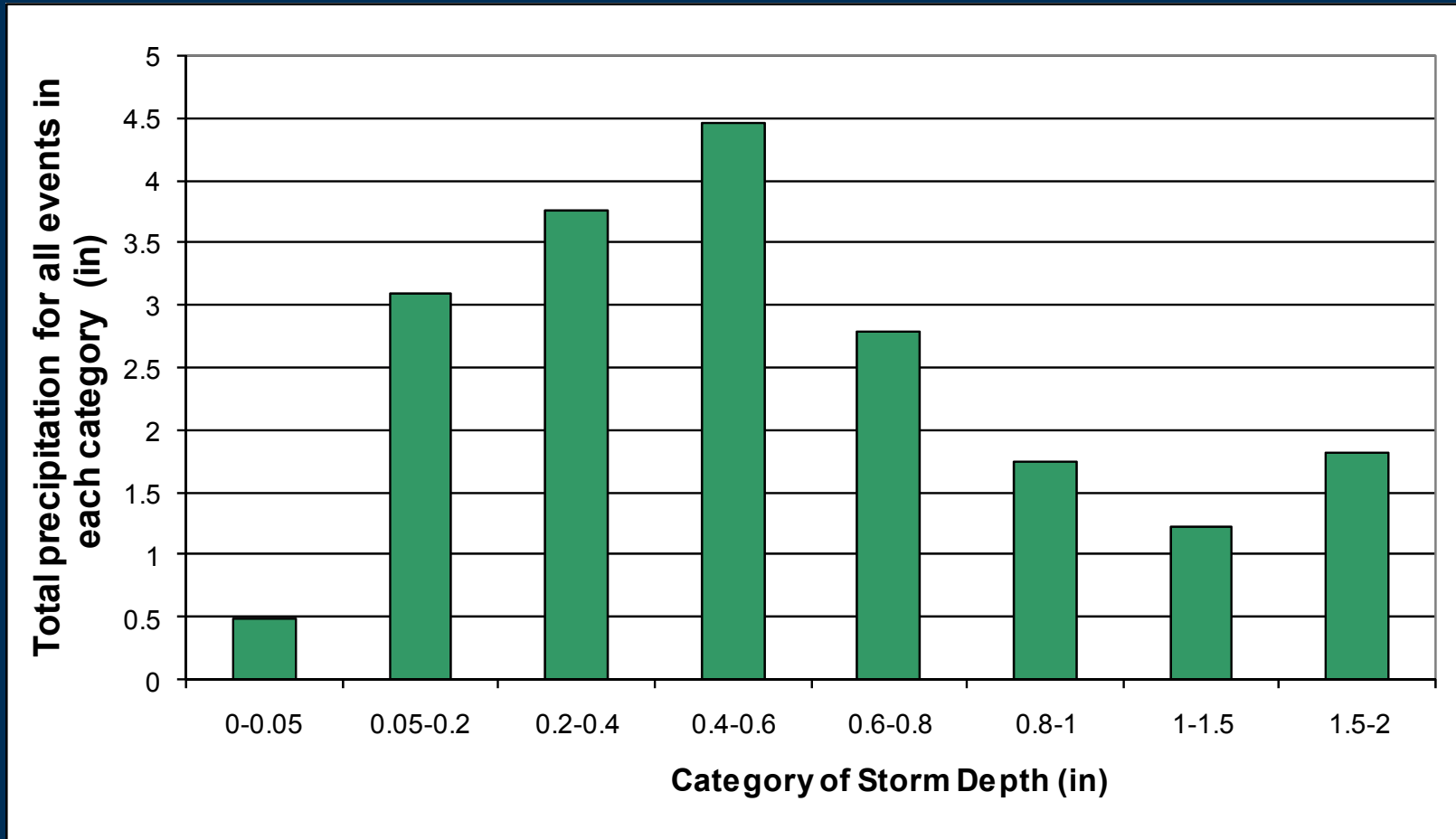


Number of rainfall events



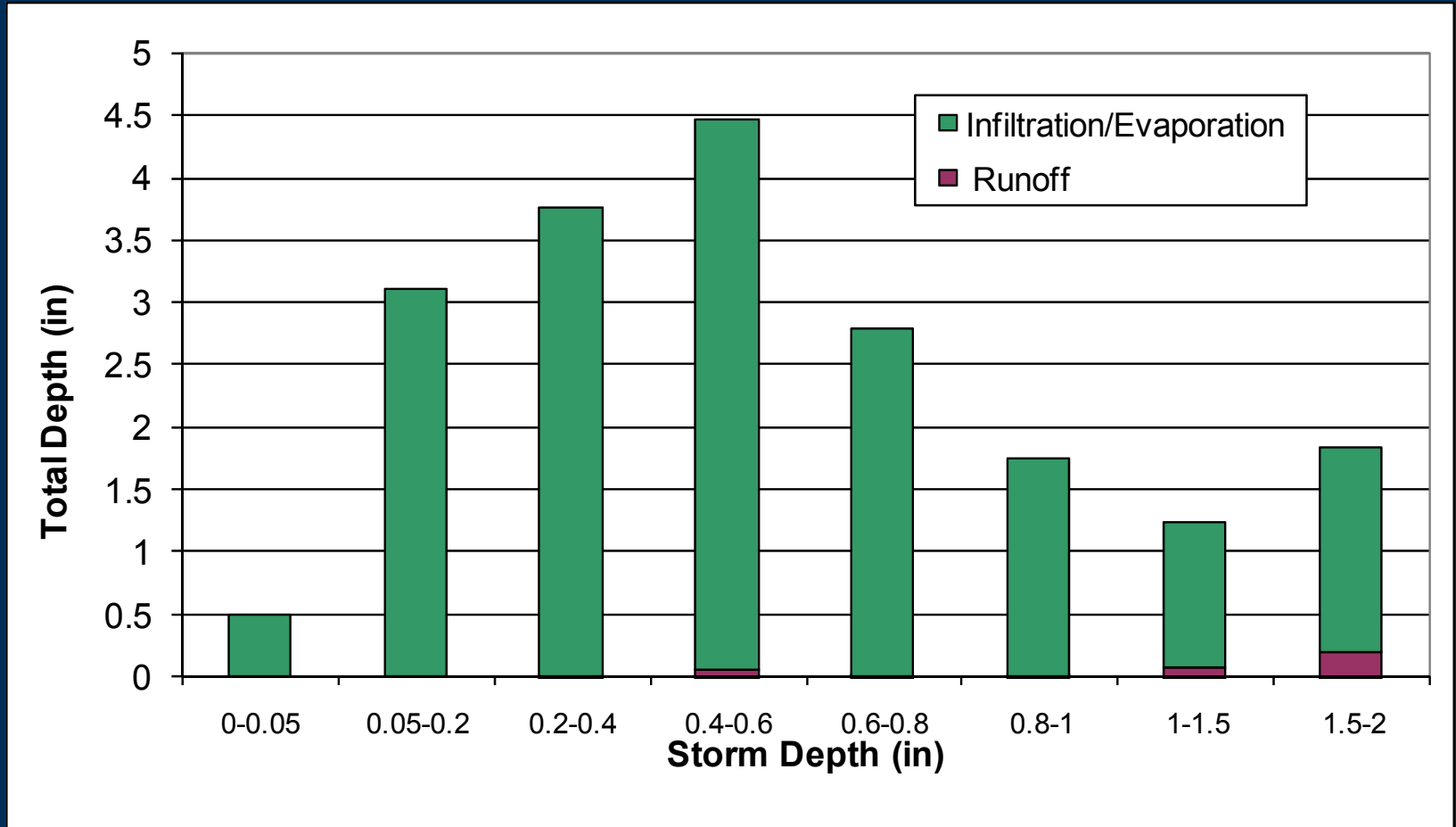
Data: May 2005-August 2007

Total precipitation by category of storm depth



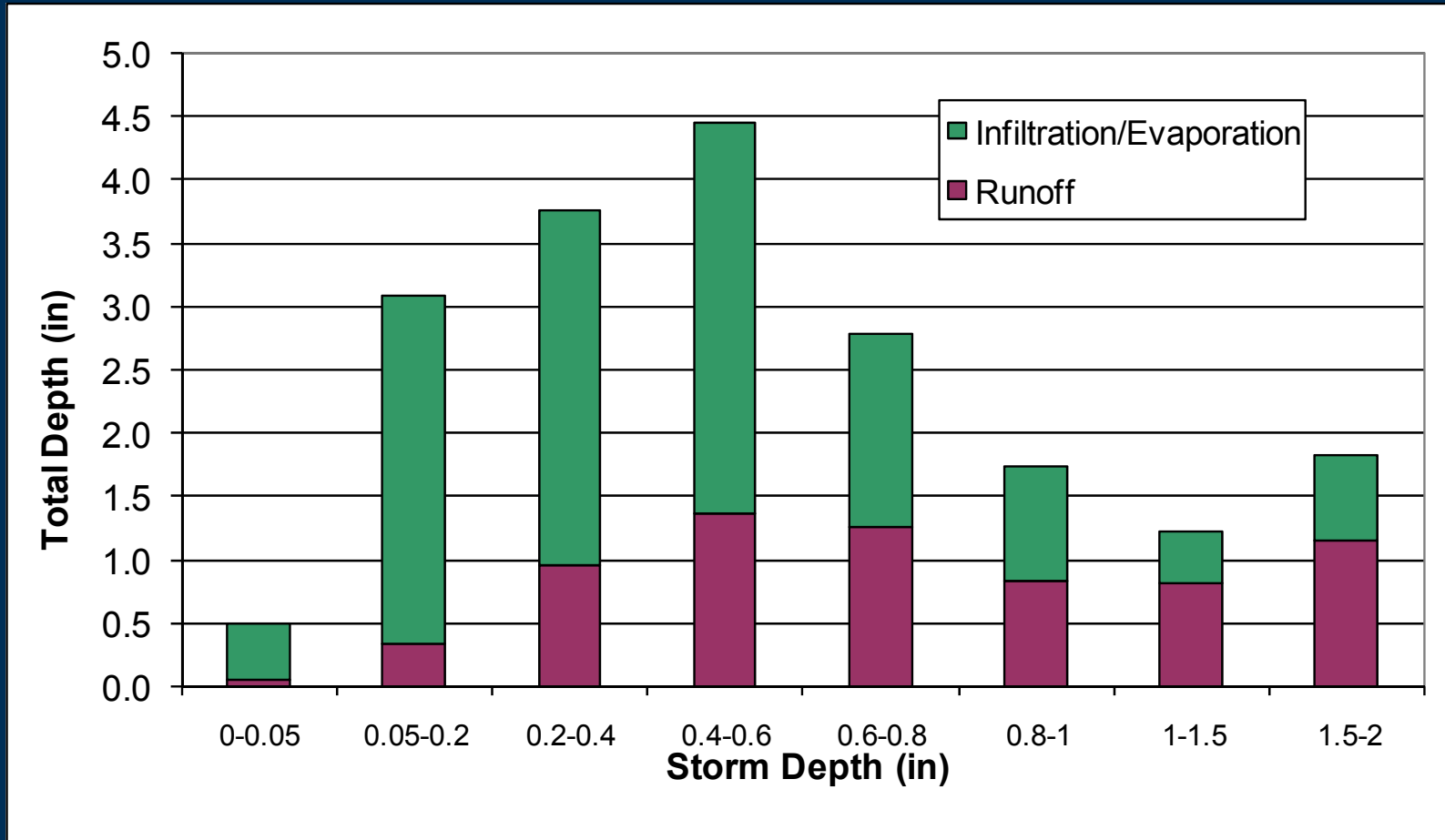
Data: May 2005-August 2007

Grassland runoff coefficient



Data: May 2005-August 2007

Urban runoff coefficient



Data: May 2005-August 2007

KINEROS2 runoff model

■ Satellite

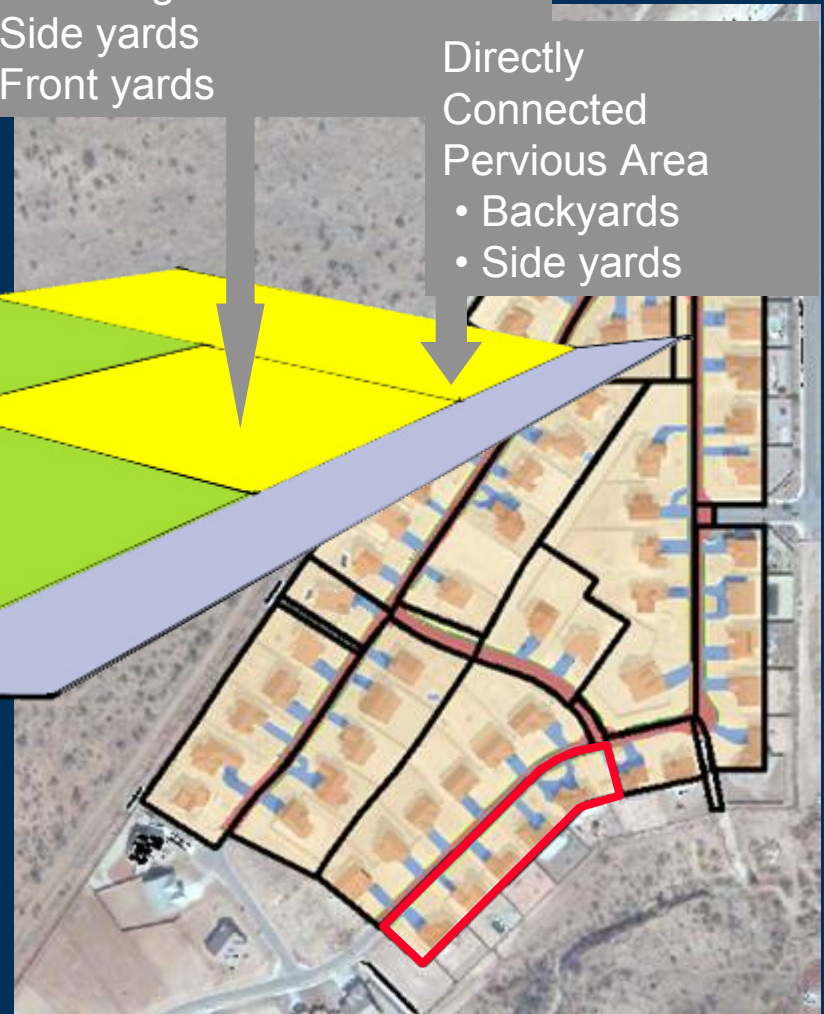
- Directly Connected Impervious Area
- Driveways

- Indirectly Connected Impervious Area
- Roofs
 - Sidewalks

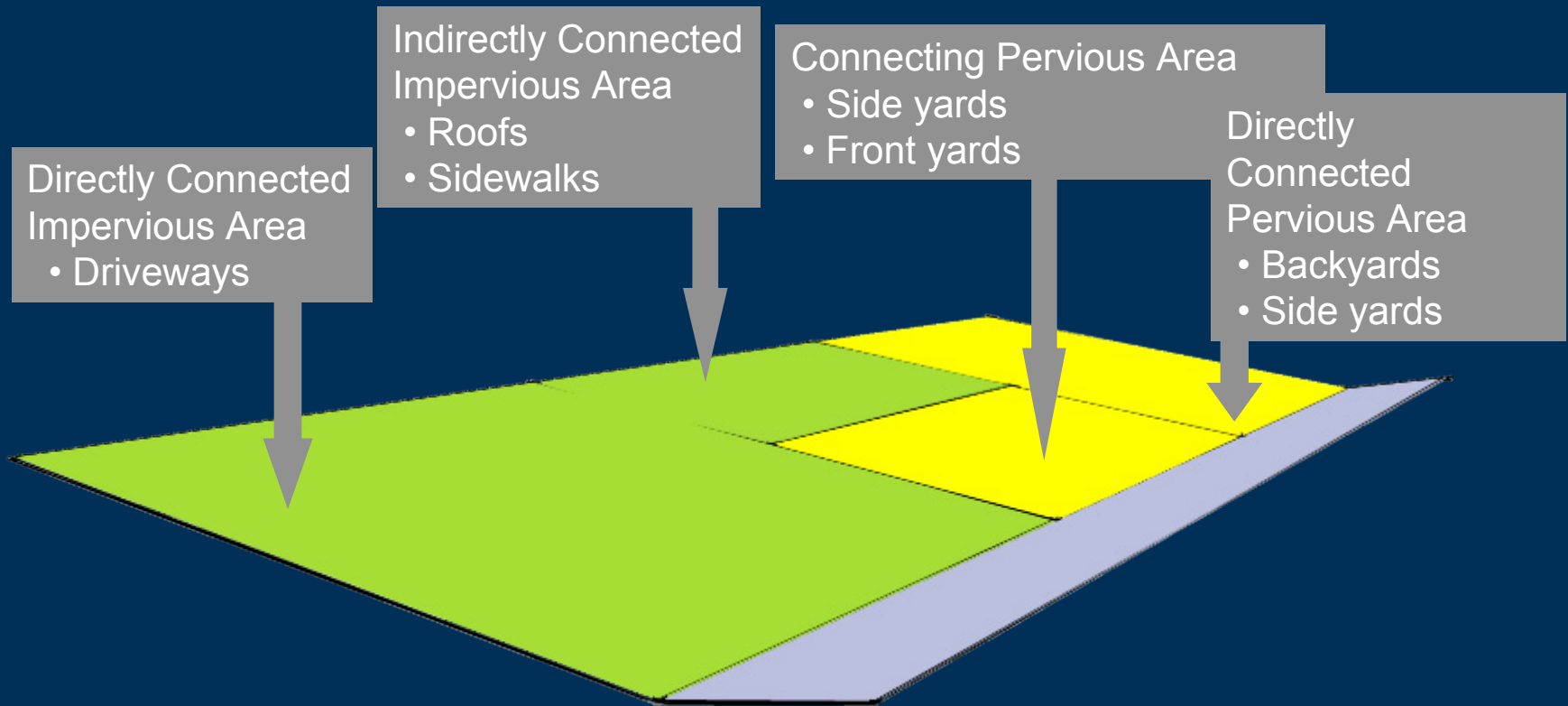
- Connecting Pervious Area
- Side yards
 - Front yards

- Directly Connected Pervious Area
- Backyards
 - Side yards

- Rooftops, driveways, sidewalks and yards
- Water is divided into “elements”



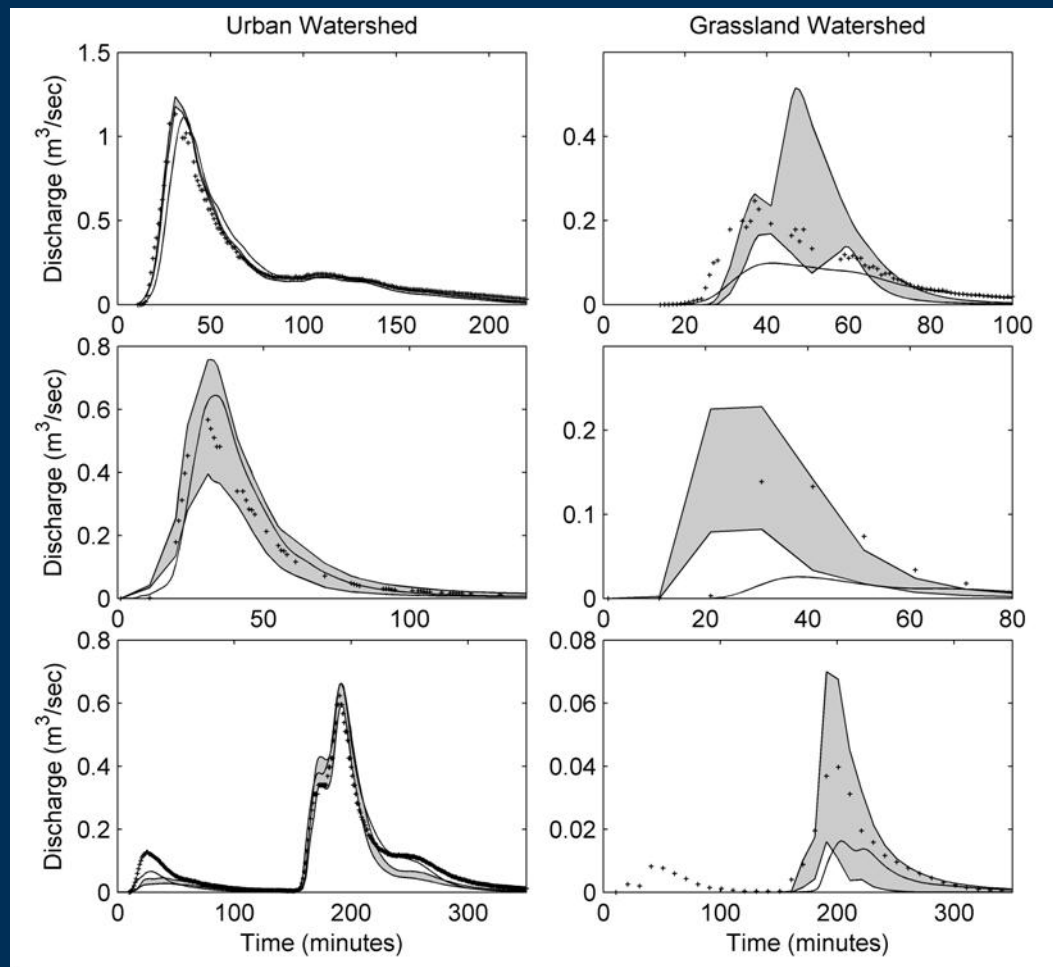
KINEROS2 runoff model



How does the rainfall-runoff model do?

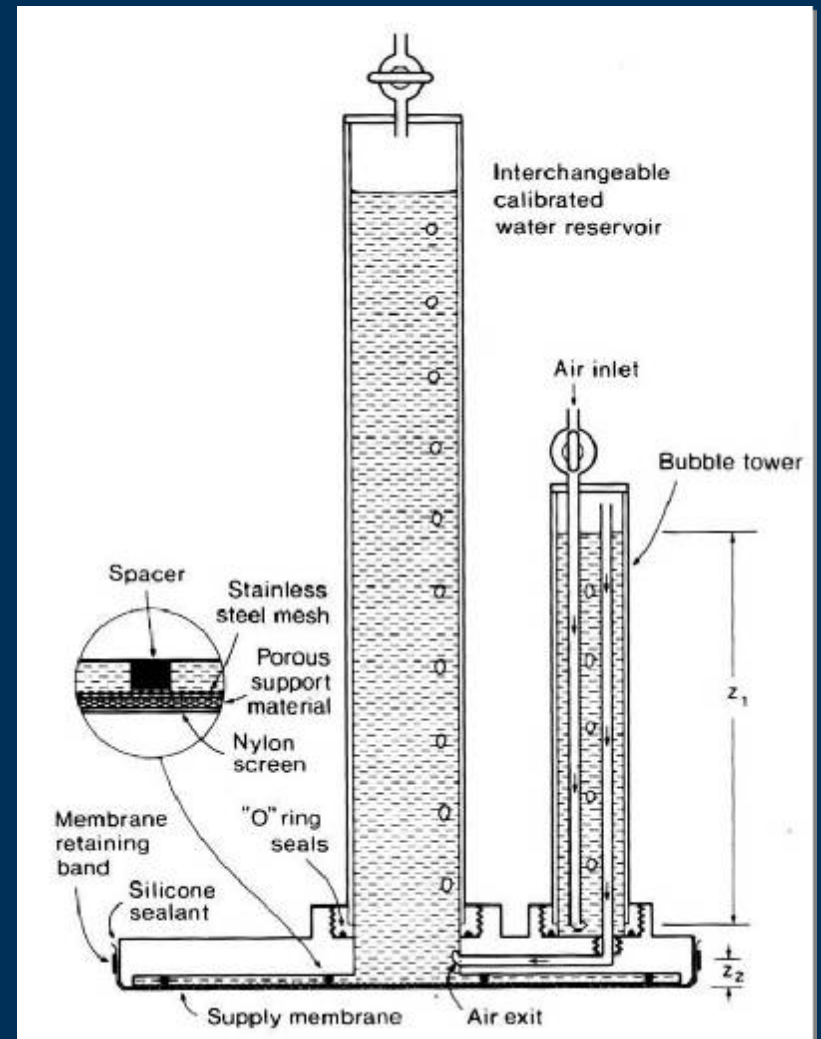
Model Output:
Shaded region

Measured Runoff:
Dots

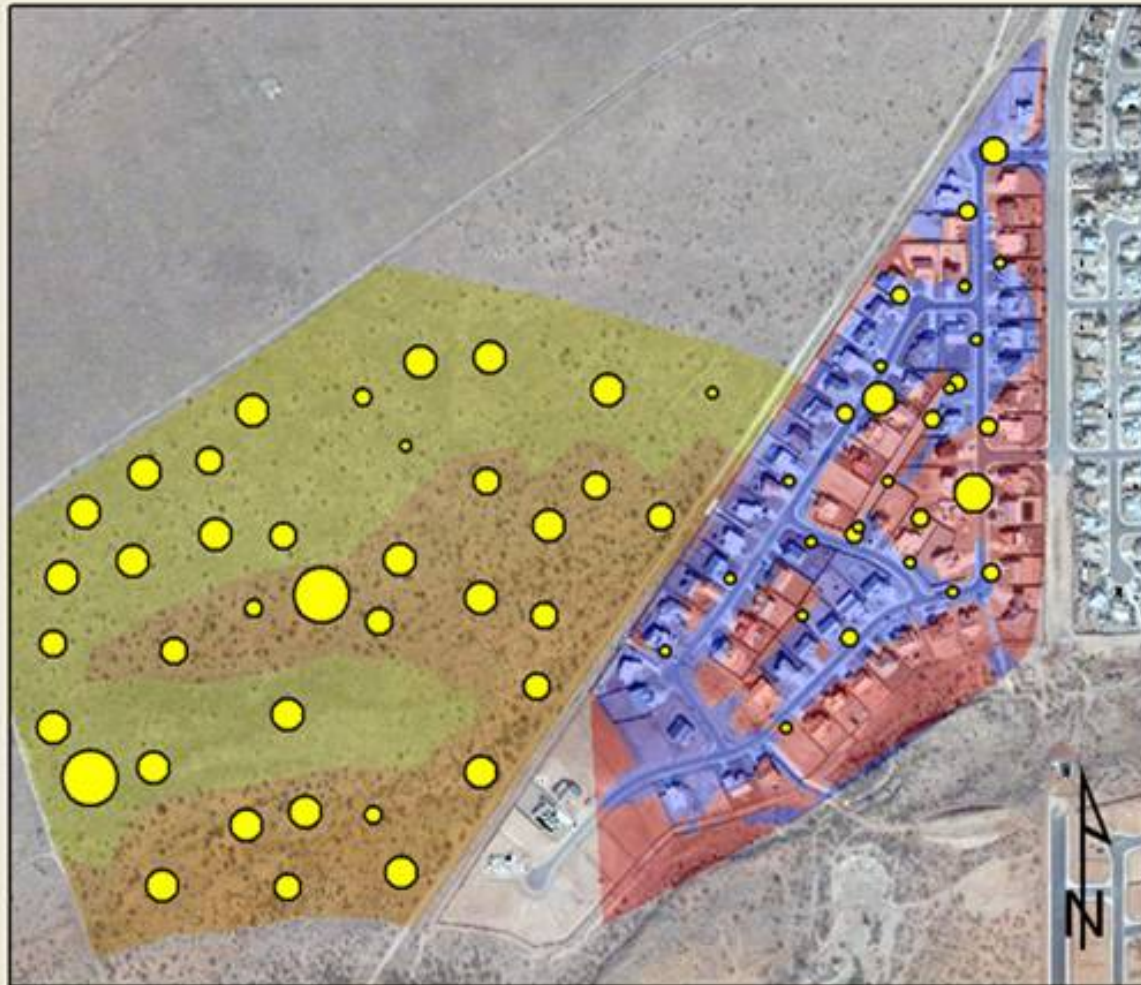


Infiltration measurement

- 70 sites in the grassland and urban watersheds
- Sampled areas of cut (soil removed) and fill (soil added)



Infiltration results



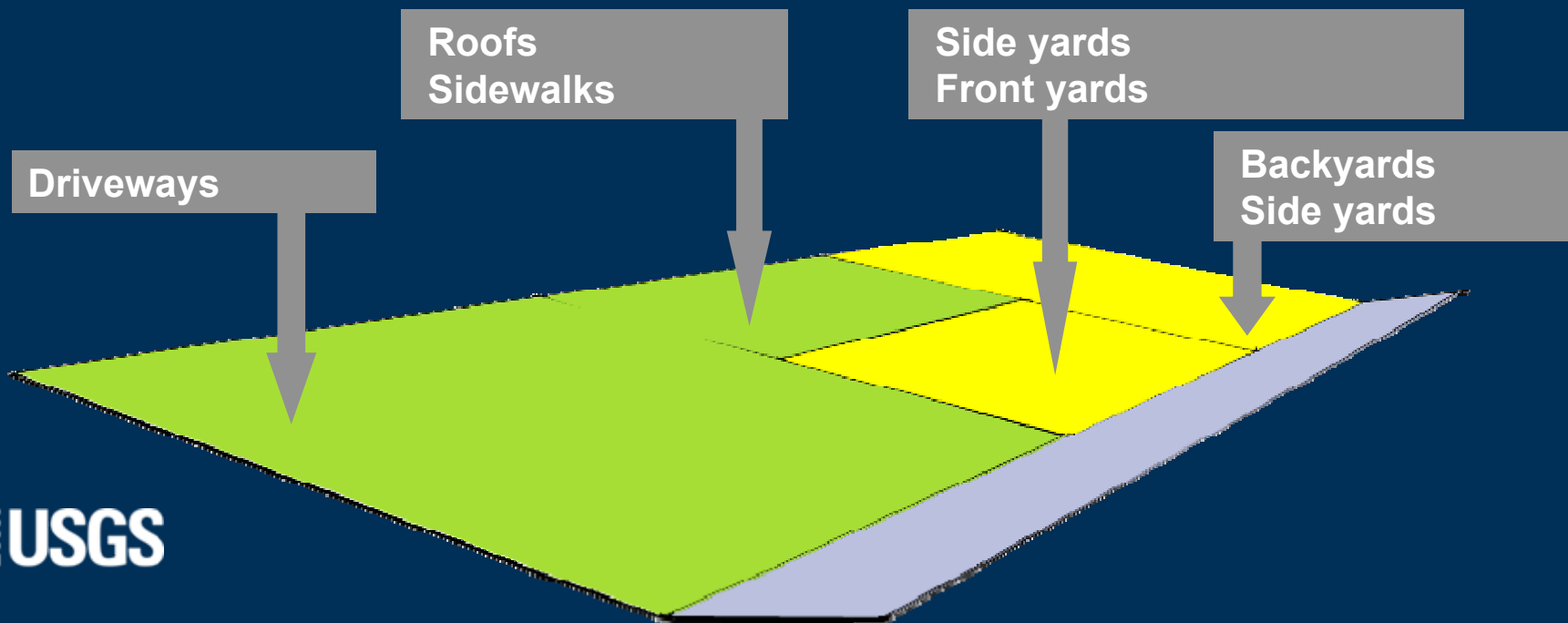
Sat. Hyd. Conductivity
mm/hr

- 1.4 - 2.8
- 2.9 - 4.3
- 4.4 - 5.7
- 5.8 - 7.2
- 7.3 - 8.6
- 8.7 - 10.1
- 10.2 - 11.6
- 11.7 - 13.0

Does soil compaction contribute to the increase in runoff?

Model A: Standard calibrated urban runoff model

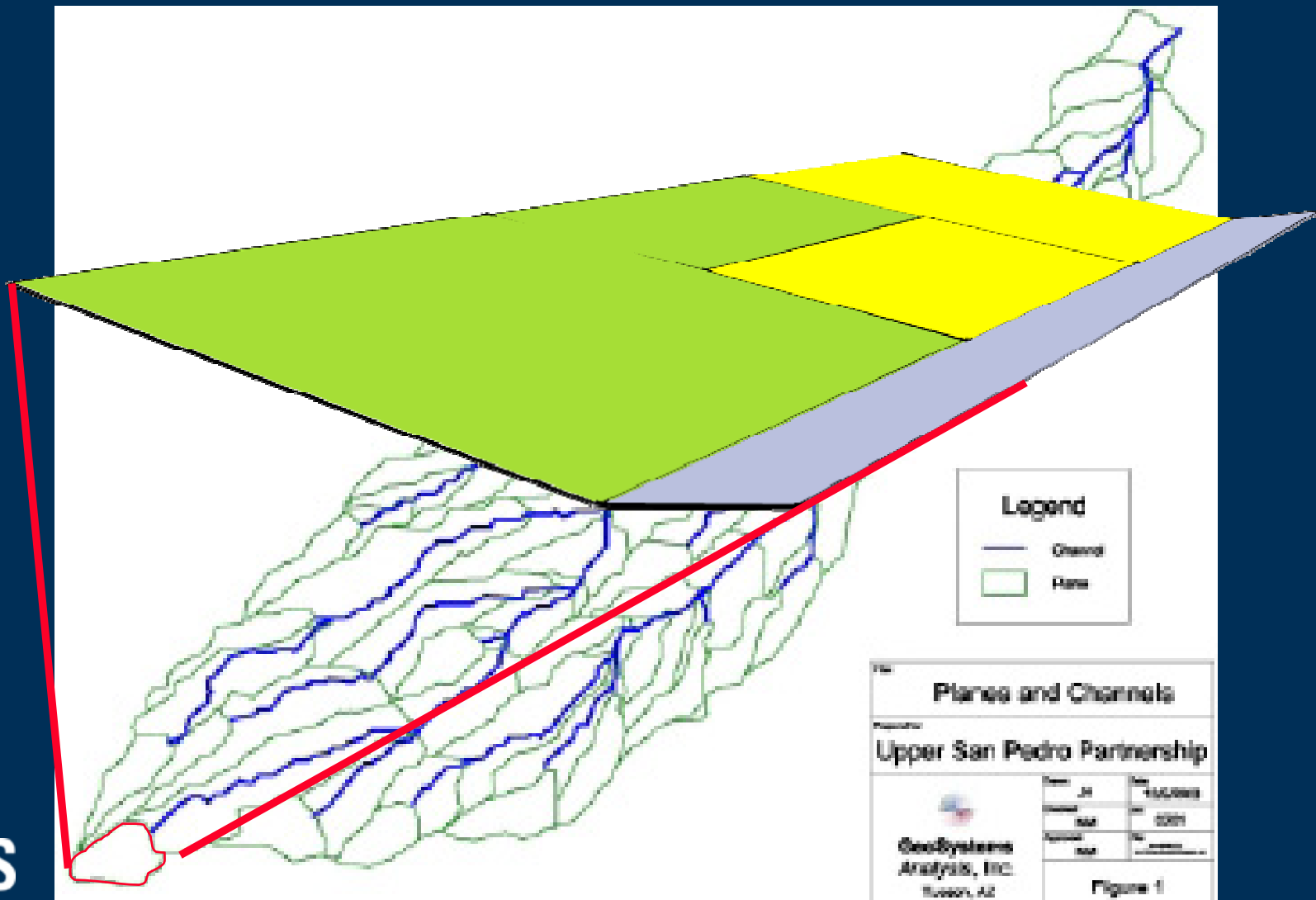
Model B: Same as A, except substituting predevelopment/grassland infiltration rates



Does soil compaction contribute to the increase in runoff?

	Model A	Model B
Precipitation over 2 years: 15.2 in.	40.5 af	40.5 af
Runoff from streets and driveways	8.9 af	8.9 af
Total runoff	19.5 af	14.1 af

GSA study



GSA study

Compared to the current study, *in the La Terraza development*, the GSA study used a:

- Lower percentage of impervious area
- Higher infiltration rates
- Coarser model discretization

All of these imply that the results from the GSA study were conservative, and that actual runoff and infiltration volumes are at least as large or larger than was predicted.

Key Points

- **Runoff has increased from 2 percent of rainfall to 37 percent of rainfall as a result of development at La Terraza.**
- **KINEROS2 can simulate runoff from the urban watershed well, *with both calibrated and field-measured infiltration rates.***
- **Soil compaction and the importation of off-site soil decrease infiltration, and cause about 1/3 of the total increase in stormwater runoff.**
- **The estimate of 200-300 acre-feet/year of increased recharge in the GSA study is probably a conservative one.**